INVESTIGATOR'S ANNUAL REPORT

United States Department of the Interior

National Park Service

All or some of the information you provide may become available to the public.

OMB # (1024-0236)
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Reporting Year:	**Park:**	**Select the type of permit this report addresses:**
2007	Shenandoah NP	Scientific Study

Name of principal investigator or responsible official:	**Office Phone:**
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No co-investigators

Project Title (maximum 300 characters):
Evolutionary response of invasive crucifer defenses to novel herbivore communities

Park-assigned Study or Activity #:	**Park-assigned Permit #:**	**Permit Start Date:**	**Permit Expiration Date:**
SHEN-00337	SHEN-2007-SCI-0007	Jun 18, 2007	Jul 30, 2007

Scientific Study Starting Date:	**Estimated Scientific Study Ending Date:**
May 13, 2007	Jun 11, 2007

For either a Scientific Study or a Science Education Activity, the status is:

Terminated before completed

For a Scientific Study that is completed, please check each of the following that applies:

__ A final report has been provided to the park or will be provided to the park within the next two years

__ Copies of field notes, data files, photos, or other study records, as agreed, have been provided to the park

__ All collected and retained specimens have been cataloged into the NPS catalog system and NPS has processed loan agreements as needed

Activity Type:
Research

Subject/Discipline:
Plant Communities (Vegetation)

Purpose of Scientific Study or Science Education Activity during the reporting year (maximum 4000 characters):

While plant-herbivore interactions have long been thought of as an important part of natural selection (e.g., Ehrlich and Raven, 1964), recent examples have shown that populations are also capable of adapting to local conditions in just a few generations. Thompsonâ s (2005) geographic mosaic theory of coevolution has perhaps been the most significant of these new ideas, proposing that local differences in the strength of interspecific interactions create coevolutionary â hotspotsâ where evolution proceeds particularly quickly, and that the distribution of these hotspots throughout a species range could be largely responsible for the maintenance of genetic variation throughout a speciesâ range.

During the same time period, the evolutionary impact of differing herbivore communities has been an important topic to ecologists studying the spread of invasive species. Some researchers have argued that species experiencing enemy release benefit not only from reduced predation, but from the opportunity to evolutionary re-allocate energy away from defenses (Blossey and Notzold, 1995). This hypothesis, however, assumes that high concentrations of many plant defenses exist in order to deter the specialist herbivores plants

have escaped from during invasion, while classical plant defense theory hypothesizes that defense chemicals are likely to have evolved primarily to repel generalist herbivores (Feeny, 1976). Specialist herbivores, on the other hand, are more likely to have metabolic or behavioral mechanisms for avoiding defenses, and in many cases may even use chemicals as feeding stimulants (Renwick, 2002). If defense chemicals primarily repel generalists, and simultaneously serve as attractants to specialists, then invasive species experiencing enemy release may actually increase their fitness by increasing defense levels (Muller-Scharer et al., 2004). Furthermore, Thompsonâ s geographic mosaic models suggest that differences in herbivore communities may drive defense evolution not only across continents but on a fairly small scale. Here, I propose a research program designed to test the Muller-Scharer model of invasive species evolution in several members of the plant family Brassicaceae that have been introduced to North America.

I intend to study these questions in Barbarea vulgaris, Brassica nigra, and Hesperis matronalis, three members of the plant family Brassicaceae (cruciferous plants). Using three species provides natural replication and makes generalizing my results more tenable. As many members of the Brassicaceae share specialists and inhabit similar habitats, however, looking at several species will not be as difficult as it would be if they were completely unrelated.

The Brassicaceae are an ideal study system for this question for several reasons. First, the widely studied model species Arabidopsis thaliana is a member of this family, which means that a wealth of information on at least one cruciferâ s physiological and genetic traits is available. Second, many European crucifers are invasive in the US (Uva, 1997). Finally all members of this family produce glucosinolate defense chemicals, the first defenses shown to follow the patterns described above (Verschaffelt, 1910).

Furthermore, evidence suggests that glucosinolate levels in North America are likely to be susceptible to natural selection. Despite the genetic bottlenecks associated with invasion, both life-history (Griffith et al., 2004) and glucosinolate levels (Cipollini et al., 2004) vary between populations in North America. Patterns of genetic diversity in introduced crucifers also do not differ greatly from those seen in native populations (Bossdorf et al., 2005; Gaskin et al, 2005). Finally, defense levels in the Brassicaceae are highly heritable and have responded rapidly to artificial selection in agricultural experiments (Stowe, 1998).

Findings and status of Scientific Study or accomplishments of Science Education Activity during the reporting year (maximum 4000 characters):

As part of an ongoing project to monitor defense chemical concentrations in invasive mustards, plant and insect specimens were collected last summer from three sites in Shenandoah National Park. On May 13-15th 2007, I located three areas of the park with noticeable populations of Barbarea vulgaris (winter cress), an early-flowering mustard and invasive species. I set up delta traps â cardboard triangles with sticky interiors that capture insects â at these three sites: two at the Naked Creek overlook (38Âº29.610â N, 78Âº27.099â W), one near the Rag Hill parking lot (38Âº32.669â N, 78Âº23.538â W), and one near the Gravel Springs Gap trail parking lot (38Âº46.070â N, 78Âº13.904â W). The traps were baited with a solution containing several volatile chemicals normally found in members of the plant family Brassicaceae, mainly sinigrin from horseradish.

Preliminary observations showed large populations of B. vulgaris at several locations throughout the park, both along the side of roads (mainly Skyline Drive) and in other disturbed areas. Large populations of this species also occurred in old-field areas, specifically in the clearing at the Naked Creek overlook. However, no significant populations were observed in high-quality native fields (such as Big Meadows) or in wooded areas, so park efforts to control this noxious weed appeared to be fairly productive.

I observed my other main study species, Hesperis matronalis (Dameâ s Rocket) only in small numbers in the park, near the Gooney Run overlook (38Âº50.560â N, 78Âº12.459â W). As it is usually found in more northern areas of the US it was unsurprising that its population density here was low.

Traps were picked up again roughly one month later, on June 11th. Few or no targeted insects (cabbage white butterflies, Pieris rapae) were caught in traps, a trend that would continue throughout the summer. Most trapped insects were common dipterans. However, field observations showed large numbers of cabbage whites, especially at Naked Creek. Ten plants were collected from each of the three sites, along with seed samples from an additional fifteen plants at each site.

Unfortunately, due to budgetary constraints and changes in research priorities, it eventually became apparent that I would be unable to analyze these samples as planned or to continue this project in the future. Therefore, more detailed biotic surveys of sampled insects has not taken place, and this project has been prematurely terminated. All samples have been incinerated as appropriate for invasive plant material.

For Scientific Studies (not Science Education Activities), were any specimens collected and removed from the park but not destroyed during analysis?	
No	
Funding specifically used in this park this reporting year that was provided by NPS (enter dollar amount): $0	**Funding specifically used in this park this reporting year that was provided by all other sources (enter dollar amount):** $0
List any other U.S. Government Agencies supporting this study or activity and the funding each provided this reporting year:	

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